US-PAT-NO: 5940101

DOCUMENT-IDENTIFIER: US 5940101 A

TITLE: Method and apparatus for determining optimum ink drop formation-frequency in an ink jet printer

DATE-ISSUED: August 17, 1999

INVENTOR-INFORMATION:

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US-CL-CURRENT: 347/78

ABSTRACT:

The optimum excitation frequency for forming successive ink drops in an ink jet printer is determined by forming a sequence of ink drops at a plurality of different drop-formation frequencies and phases thereof and integrating a detected current representative of the value of the charge on the ink drops as a function of time for each the plural frequencies and phases thereof to create a corresponding plurality of waveforms. The frequency of the optimum waveform, which minimizes the undesired formation of satellite ink drops and undesired drop dispersion, is then selected for use during the next print mode. The optimum waveform is characterized by a single maxima and minima separated in phase by a value no greater than a predetermined maximum value.

19 Claims, 10 Drawing figures

Exemplary Claim Number: 1

Number of Drawing Sheets: 8

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Brief Summary Text - BSTX (5):

Various Ink jet recording apparatus of the continuous jet type are conventionally known and practically used. An exemplary one of such conventional continuous jet type ink jet recording apparatus is disclosed, for

example, in Japanese Patent Laid-Open Application No. Heisei 4-220350 and shown in FIG. 10. As presented in FIG. 10 the continuous jet type ink jet recording apparatus shown includes, as principal components thereof, a nozzle 1 having a circular orifice of a very small diameter, an ink electrode 2 for holding the potential of ink in the nozzle 1 at the ground level, an oscillator 3 in the form of a piezoelectric oscillator mounted on the nozzle 1, a control electrode 4 having a circular opening or a slit-like opening coaxial with the nozzle 1 and connected to receive a charge controlling signal to control charging of a jet of ink in accordance with image data, a grounding electrode 5 disposed in the rear (rightwardly in FIG. 10) of the control electrode 4 and grounded itself, a knife edge 6 mounted on the grounding electrode 5, a deflection power supply E1, a deflection electrode 7 connected to the deflection power supply E1 for cooperating with the grounding electrode 5 to produce therebetween an intense electric field perpendicular to an ink jet flying axis to deflect a charged ink drop to the grounding electrode 5 side, a reference oscillator CG for generating a reference clock signal CLK of an oscillation frequency instructed from a microprocessor unit (hereinafter referred to simply as MPU) not shown, a frequency divider FD for dividing the frequency of the reference clock signal CLK by N (positive integer) to produce an excitation signal PCLK, a delayed pulse generator DG for delaying the excitation signal PCLK to produce excitation signals PCLK of phases .theta..sub.0, .theta..sub.1, .theta..sub.2, . . . , .theta..sub.N-1 delayed to N (positive integer) stages in response to the reference clock signal CLK, a multiplexer MP for selecting one of the excitation signals PCLK of the thus delayed phases .theta..sub.0, .theta..sub.1, .theta..sub.2, . . . , .theta..sub.N-1, an oscillation element driver VD for driving the oscillator 3 with the excitation signal PCLK of the phase .theta. selected by the multiplexer MP, a pulse width modulator PM for converting image data into a pulse width signal corresponding to a density gradation, a synchronizing circuit SC for synchronizing a rising or falling edge of the output of the pulse width modulator PM with a rising or falling edge of the excitation signal PCLK from the frequency divider FD, and a high voltage switch HVS for voltage amplifying and applying the output of the

synchronizing circuit SC as a charge controlling signal to the control electrode 4. It is to be noted that reference character DR denotes a rotary
drum around which a recording medium is wrapped.

Detailed Description Text - DETX (2):
As shown in FIG. 1, there is shown a continuous jet type ink jet recording
apparatus to which the present invention is applied. The continuous jet type
ink jet recording apparatus shown includes, as principal components thereof, a
nozzle 1 having a circular orifice of a very small diameter, an ink electrode 2
for holding the potential of ink in the nozzle 1 at the ground level, an
oscillator 3 in the form of a piezoelectric oscillator mounted on the nozzle 1,
a control electrode 4 having a circular opening or a slit-like opening coaxial
with the nozzle 1 and connected to receive a charge controlling signal to
control charging of a jet of ink in accordance with image data, a grounding
electrode 5 disposed in the rear of the control electrode 4 and grounded
itself, a knife edge 6 mounted on the grounding electrode 5, a deflection power
supply E1, a deflection electrode 7 connected to the deflection power supply E1
for cooperating with the grounding electrode 5 to produce therebetween an
intense electric field perpendicular to an ink jet flying axis to deflect a
charged ink drop to the grounding electrode 5 side, a switch SW1 for switchably
connecting the deflection electrode 7 to the deflection power supply E1 or the
ground, a reference oscillator CG for generating a reference clock signal CLK
of an oscillation frequency instructed from an MPU 10, a frequency divider FD
for dividing the frequency of the reference clock signal CLK by N (positive
integer) to produce an excitation signal PCLK, a delayed pulse generator DG for
delaying the excitation signal PCLK to N (positive integer) stages in response
to the reference clock signal CLK to produce pulse trains .theta..sub.0,
.theta..sub.1, .theta..sub.2, . . . , .theta..sub.N-1, a multiplexer (2) MP2
for selecting one of the delayed pulse trains .theta..sub.0,
.theta..sub.1,
.theta..sub.2, ...theta..sub.N-1, an oscillation element driver VD for
driving the oscillator 3 with the pulse signal selected by the multiplexer (2)
MP2, a pulse width modulator PM for converting image data into a pulse width
signal corresponding to a density gradation, a probe pulse generator PG for

generating a probe pulse signal having a pulse width sufficiently shorter than the period of the excitation signal PCLK in synchronism with a rising or falling edge of the excitation signal PCLK, a synchronizing circuit SC for synchronizing a rising or falling edge of the output of the pulse width modulator PM with a rising or falling edge of the excitation signal PCLK from the frequency divider FD, a multiplexer (1) MP1 for selecting one of the probe pulse signal from the probe pulse generator PG and the output of the synchronizing circuit SC, a high voltage switch HVS for voltage amplifying and applying the output of the multiplexer (1) MP1 as a charge controlling signal to the control electrode 4, a conductive drop catcher 8 disposed at a position (hereinafter referred to as home position) in a region, which does not participate in recording, rearwardly of the grounding electrode 5 and the deflection electrode 7 and serving also as a detection electrode, a shield line 9 having an end connected to the conductive drop catcher 8, a current detector (current to voltage converter) CD for measuring the charge of ink drops discharged from an ink jet to the conductive drop catcher 8, an analog to digital (A/D) converter ADC for converting the output of the current detector CD from an analog signal into a digital signal, and the MPU 10 for controlling the reference oscillator CG to oscillate with an oscillation frequency of the reference clock signal CLK in response to the output of the analog to digital converter ADC. It is to be noted that the MPU 10 also controls the entire system of the continuous jet type ink jet recording apparatus of the present embodiment.